

What is Claimed Is:

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2 1. In an industrial equipment network for interconnecting a plurality of devices, apparatus  
3 for permitting an associated SCADA system to be self-configuring, comprises:

4 a plurality of controllers dedicated to each one of said plurality of devices,  
5 respectively, for providing each with control and data functions for interacting with other of  
6 the devices in the equipment network, and other systems, and programming each controller to  
7 provide the interconnection of its associated device with other ones of said plurality of  
8 devices;

9 a computer network;

10 means connected between said computer network and said plurality of controllers,  
11 respectively, for transferring data and/or control signals between individual ones of said  
12 plurality of controllers and said computer network at given times; and

13 auto-discovery means for permitting said SCADA system to both self-configure itself  
14 relative to devices in said industrial equipment network, and to be updated relative to changes  
15 in the configuration of said industrial equipment, and associated devices or equipment therein,  
16 including discovering new or changed devices via communication over said computer  
17 network.

1 2. The apparatus of Claim 1, wherein said plurality of controllers are each provided by a  
2 programmable logic controller (PLC).

1     3.     The apparatus of Claim 1, wherein said transfer means is selected from the group  
2     consisting of a router, and switch.

1     4.     The apparatus of Claim 1, wherein said computer network consists of a local area  
2     network (LAN).

1     5.     The apparatus of Claim 1, wherein said auto-discovery means includes:  
2             broadcast means for operating a controller of a given device, that has either changed its  
3     configuration or is new to said industrial equipment network, to broadcast over said computer  
4     network an auto-discovery protocol; and  
5             server means included in said SCADA system responsive to an auto-discovery  
6     protocol from said given device, for interrogating said controller of said given device to access  
7     sufficient data to permit said SCADA system to update its configuration for the given device  
8     itself and within the industrial equipment network.

1     6.     The apparatus of Claim 1, wherein said auto-discovery means includes:  
2             server means included in said SCADA system and connected to said computer  
3     network, for in a first mode of operation periodically polling respective controllers of all of  
4     said plurality of devices in said industrial equipment network for any respective changes in  
5     configuration and identification of new ones of said plurality of devices, and in a second mode  
6     of operation individually interrogating each responding one of said plurality of devices for  
7     new data to permit said SCADA system to update its configuration information.

1     7.     A method for permitting a Supervisory Control and Data Acquisition system  
2     (SCADA) to automatically diagram the interconnection and interaction, and changes thereto,  
3     between a plurality of pieces of industrial equipment and/or a plurality of devices that may be  
4     connected to one another and to a data network, said method comprising:

5             establishing a network over which a plurality of said plurality of pieces of industrial  
6     equipment and/or devices can selectively communicate with one another and with a SCADA  
7     system;

8             connecting different ones of said plurality of pieces of industrial equipment and/or  
9     devices each to either a common controller, or each to individual dedicated controllers,  
10    respectively, or each to a plurality of controllers, or some combination thereof; and

11            programming each controller for controlling and identifying its associated piece of  
12    industrial equipment and or device, and for sending data representative of the interconnection  
13    and interaction thereof with other ones of said plurality of pieces of industrial equipment  
14    and/or devices, both to the latter equipment and/or devices, and to said SCADA system over  
15    said data network.

1     8.     The method of Claim 7, further including the steps of:

2             assigning a unique IP address to each one of said plurality of pieces of industrial  
3     equipment and/or devices upon their request as they are connected to the network;

4             broadcasting onto the data network an auto-discovery protocol including the associated  
5     IP address from each piece of equipment or device when it is added to the network, or  
6     thereafter when a change is made to its interconnections and interaction with other of said  
7     plurality of pieces of equipment, and/or devices;

8           acknowledging via a server of said SCADA system the receipt of an auto-discovery  
9   request;  
10          transferring to said server a description of the associated piece of equipment or device,  
11   to permit said SCADA system to configure monitoring;  
12          operating said SCADA system to automatically monitor either by polling or receiving  
13   broadcasts from said piece of equipment or device; and  
14          programming said SCADA system to automatically update and include the associated  
15   piece of equipment or device in a diagram identifying and showing each, and their interaction  
16   with other ones of said plurality of pieces of equipment and/or devices.

1   9.     The method of Claim 8, wherein an extensible mark-up language (XML) is used for  
2   describing or providing information for each one of said plurality of pieces of industrial  
3   equipment or devices, respectively.

1   10.    The method of Claim 7, further including the steps of:  
2          assigning a unique IP address to each one of said plurality of pieces of industrial  
3   equipment and/or devices upon their request as they are connected to the network;  
4          programming a server in said SCADA system to periodically poll said plurality of  
5   pieces of industrial equipment and/or devices;  
6          operating a controller of each polled device or piece of industrial equipment to respond  
7   to a discovery request from said server by providing a description thereof; and  
8          operating said server to use the description to configure monitoring of the associated  
9   device or piece of industrial equipment, whereafter device or equipment monitoring begins.

1     11.     The method of Claim 10, wherein an extensible mark-up language (XML) is used by  
2     an associated controller to describe each polled device or piece of industrial equipment.

1     12.     The method of Claim 7, further including the steps of:  
2             configuring each dedicated controller for having its associated device or piece of  
3     industrial equipment interconnect and interact with selected other ones of said plurality of  
4     pieces of industrial equipment and/or devices;  
5             operating each controller for connecting its associated device or piece of equipment to  
6     said network;  
7             operating each controller and a server in said SCADA system for providing auto-  
8     discovery by the latter of each device and/or piece of equipment;  
9             operating each controller to respond to a request from said server to provide both a  
10    description of the associated device and/or piece of equipment, and its interaction with other  
11    devices and/or pieces of equipment;  
12            operating said server, in response to the description and interaction of said plurality of  
13    devices and/or pieces of equipment, to initially establish and thereafter update a database and  
14    a user interface of said SCADA system; and  
15            operating said server to begin monitoring the associated device.

1     13.     The method of Claim 12, wherein an extensible mark-up language (XML) is used to  
2     describe each device and/or piece of equipment, and their respective interaction.

1     14.     The method of Claim 12, further including in said step of operating each controller and  
2     a server in said SCADA system for providing auto-discovery, the steps of:  
3             measuring the time for said server to respond to a controller of a device or piece of  
4     equipment awaiting a reply; and  
5             indicating a network fault, and interrupting further SCADA system processing for the  
6     associated device or piece of equipment, if no reply is received within a predetermined period  
7     of time.

1     15.     The method of Claim 7, further including the steps of:  
2             configuring each dedicated controller for having its associated device or piece of  
3     industrial equipment interconnect and interact with selected other ones of said plurality of  
4     pieces of industrial equipment and/or devices;  
5             operating each controller for connecting its associated device or piece of equipment to  
6     said network;  
7             operating each controller to request a reply from a respective controller of each  
8     selected one of other of said plurality of devices and/or pieces of equipment;  
9             operating each controller to wait for a reply; and  
10            operating a requesting controller in response to a reply from another controller to  
11     provide the latter with data for updating a database of its associated device or piece of  
12     equipment with identification and interconnection data associated with the device or piece of  
13     equipment of the requesting controller.

1    16     The method of Claim 15, wherein said step of operating each controller to wait for a  
2    reply further includes the steps of:

3            measuring the time from making a request for reply to the receipt of a reply; and  
4            indicating a network fault and interrupting further processing if no reply is received  
5    within a predetermined period of time.

1    17.     The method of Claim 12, further including the steps of:

2            operating each controller to request a reply from a respective controller of each  
3    selected one of other of said plurality of devices and/or pieces of equipment;  
4            operating each controller to wait for a reply; and  
5            operating a requesting controller in response to a reply from another controller to  
6    provide the latter with data for updating a database of its associated device or piece of  
7    equipment with identification and interconnection data associated with the device or piece of  
8    equipment of the requesting controller.

1    18.     The method of Claim 17, wherein said step of operating each controller to request  
2    contact from a respective controller of each one of said plurality of devices and/or pieces of  
3    equipment, further includes the steps of:

4            measuring the time from making a request for reply to the receipt of a reply; and  
5            indicating a network fault and interrupting further processing if no reply is received  
6    within a predetermined period of time.

1 19. The method of Claim 12, wherein said step of operating each controller and a server in  
2 said SCADA system for providing auto-discovery by the latter of each device and/or piece of  
3 equipment, further includes the steps of:

4 assigning a unique IP address to each one of said plurality of pieces of industrial  
5 equipment and/or devices upon their request as they are connected to the network;

6 broadcasting onto the data network an auto-discovery protocol including the associated  
7 IP address from each piece of equipment or device when it is added to the network, or  
8 thereafter when a change is made to its interconnections and interaction with other of said  
9 plurality of pieces of equipment, and/or devices;

10 acknowledging via a server of said SCADA system the receipt of an auto-discovery  
11 request;

12 requesting via said server a description of the associated piece of equipment or device,  
13 to permit said SCADA system to configure monitoring;

14 operating said SCADA system to automatically monitor said piece of equipment or  
15 device; and

16 programming said SCADA system to automatically update and include the associated  
17 piece of equipment or device in a diagram identifying and showing each, and their interaction  
18 with other ones of said plurality of pieces of equipment and/or devices.

1 20. The method of Claim 12, wherein said step of operating each controller and a server in  
2 said SCADA system for providing auto-discovery by the latter of each device and/or piece of  
3 equipment, further includes the steps of:



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- 4            assigning a unique IP address to each one of said plurality of pieces of industrial
- 5 equipment and/or devices upon their request as they are connected to the network;
- 6            programming a server in said SCADA system to periodically broadcast a discovery
- 7 request poll to said plurality of pieces of industrial equipment and/or devices;
- 8            operating a controller of each polled device or piece of industrial equipment to respond
- 9 to a discovery request from said server by providing a description thereof; and
- 10           operating said server to use the description to configure monitoring of the associated
- 11 device or piece of industrial equipment, whereafter device or equipment monitoring begins.